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INDIAN CLIMATOLOGY.

Climatological Atlas of India. Published by the Authority of the Government of India, under the Direction of Sir John Eliot, K.C.I.E., F.R.S. Pp. xxxii + 120 plates. (Issued by the Indian Meteorological Department, 1906.) Price 36*s*.

THE Indian network of meteorological observations is the greatest individual organisation within the tropics, and it has, therefore, attained the greatest importance in the pursuit of meteorology and climatology. Founded in the year 1875, it can now look back upon more than thirty years of uninterruptedly successful activity, having during this period had the peculiarly good fortune to be presided over by two distinguished meteorologists—Henry F. Blanford and Sir John Eliot. From the commencement the author of this review has followed with sympathetic interest the development and the active work of the organisation, has been in constant association with its director, and has also, as far as possible, made use of the immense volume of information. In no meteorological organisation in the world are there such comprehensive records, as well of a statistical as of a scientific nature, as in the Indian one; only the much older Russian one can compare with it. Beginning with the smaller, but very valuable, scientific essays of Blanford in the Proceedings of the Asiatic Society of Bengal, it grew into the huge folio volumes of the Indian Meteorological Memoirs, of which the seventeenth volume is completed and published. Then came monographs relating to individual cyclones, Blanford's "Indian Meteorologist's *Vade Mecum*" (Calcutta, 1877), and especially the five volumes of cyclone memoirs by Sir John Eliot, and his "Handbook of Cyclonic Storms in the Bay of Bengal" (second edition, Calcutta, 1900).

The introductory text to the "Climatological Atlas" gives a summary of the publications of the Meteorological Department, relates the history of the development of the department, and describes its objects and aims. Reference may here be permitted to an older publication, "Memoirs of the Indian Surveys," by Sir Clements R. Markham, K.C.B., F.R.S. (second edition, London, 1878, xvi., pp. 275–310), in which is minutely described the beginnings of meteorological efforts in India, down to the establishment under Blanford of a single organisation; it also gives a very good analysis of the meteorological work until the year 1875. The text of the "Atlas" contains the most important facts as to the principles on which the construction of the charts is based; the means are critically derived from the observations of the twenty-five years 1876–1900.[1]

The Indian network of meteorological observations extends from about latitude 6° N., in the tropical Indian Ocean, to the prodigious plateaus of the Himalayas, under 35° N. It includes, in the south as well as in the north, hill stations at and above 6000 feet above sea-level, which supply information on the upper strata of the atmosphere. The region contains the hottest and the most rainy parts of the world, and it is the scene of one of the most peculiar meteorological phenomena—the south-west monsoon—in which the wind *régimes* of the two hemispheres meet between 30° S. and about 30° N.

From the accumulated meteorological records in this highly interesting region we have now this splendid chartographic production, the "Climatological Atlas of India." This work excels in its completeness even the similar work the "Atlas Climatologique de l'Empire de Russie" (St. Petersburg, 1900). In a certain sense these two great works are complementary to each other, giving us such a very extensive picture of the climatic variations over the largest continental area of the world—Asia and Europe—as one would hardly have hoped for a short time ago. The "Indian Climatological Atlas" contains a very valuable peculiarity—it takes into consideration the *daily* variation of the meteorological elements, explaining their extension over the country during the extreme day hours 8 a.m. (10 a.m. for pressure) and 4 p.m., and also the daily variations of pressure and temperature. In India these daily variations play a most important part. The smaller charts complete in a clear manner the information on the large charts, and they are of very great practical value.

The "Atlas" contains 120 charts in perfect technical finish, as is expected from Bartholomew's Geographical Institute. The first chart (double) exhibits in a very excellent manner the orographical features of the Indian Empire, the knowledge of which is very important for the understanding of the progress of meteorological phenomena over them. Another two-page chart shows the political divisions of India, influencing the selection of the meteorological stations. Then come four smaller maps, showing the rainfall divisions according to Blanford and Eliot respectively, the medical provinces, and the meteorological divisions for the Daily Weather Report. Upon these introductory representations follow a couple of double-page maps showing the distribution of the pressure and the winds in the opposite months January and July. These charts embrace the whole of India and the East African and Australian monsoon regions, extending from 35° S. to nearly 50° N., from Asia Minor and East Africa in the west to Japan and the greater part of Australia in the east. With these we are in a position to see at a glance the distribution of pressure with the north-east and with the south-west monsoons. Both charts are very instructive, and particularly the July one, for it shows the origin and advance of the south-west monsoon of western India, which Sir John Eliot first completely explained. A uniform decrease of pressure prevails then from the south Indian Ocean, under 30° S., up to the foot of the Himalayas, in 30° N., with a difference of pressure of close upon an inch (30·3 inches in the south and 29·4 inches in the Punjab). The wind systems of the southern and northern hemispheres unite, and there is no longer a division at the equator. This is the great summer monsoon of southern Asia, which in the whole world has nothing to compare with it.

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[1] The complete numerical values are found in various volumes of the Indian Meteorological Memoirs.

In this, as in succeeding pressure charts, it is seen that in many places the winds recorded are in opposition to the distribution of pressure (local disturbances?). In the January chart we miss the north-west monsoon over the Malay Archipelago (it is found over North Australia), although at Batavia, for example, west, north-west, and north winds prevail in January with a frequency of more than 80 per cent., and similarly also prevail in strength.

Plates xi.–xxiii. exhibit the distribution of mean pressure and the winds for each month and the year at 8 a.m., the hour of observation for the telegrams for the Daily Weather Report. Besides these there are two smaller charts showing the pressure and wind at 10 a.m. and also at 4 p.m., that is, at the hours of the daily extremes. In the quiet, cool-weather season the winds experienced undergo changes of direction in accordance with the distribution of pressure. In the Ganges valley, in May, at 4 p.m., they appear to blow against the gradient, that is, from the lower to the higher pressure, the problem of the nor'-westers, which had already occupied the attention of Blanford.

Plates xxiv.–xxxvi. show the mean pressure and the winds for the day, the smaller charts the actual diurnal range of pressure, and the range reduced to sea-level, monthly and annual. From January to May, in southern India, the daily range of pressure is as much as 0·15 inch to 0·17 inch; during and after the rainy season it diminishes to 0·13 inch or 0·12 inch. These great daily amplitudes justify the representation of the mean daily distribution of pressure. In Plates xi.–xxxvi. the monthly and annual isobars are drawn at intervals of 0·05 inch, an interval which would be ample for Europe, but for a tropical region it appears to be too large. The pressure gradient which sets the great south-west monsoon in motion does not amount to so much as 0·02 inch per degree. We see, therefore, upon some charts—February, March, October, and November—only two to four isobars over the whole of the extensive region, and sometimes it is not very clear as to the local decrease of pressure, especially over the Bay towards the east. This could have been easily remedied by specially noting the mean pressure at the Nicobars, Andamans, and on the coast of Burma.

As to the origin of the most interesting phenomenon in the meteorology of India—the bursting of the monsoon—the charts which lie before us cannot afford sufficient explanation, for the origin lies outside the limits of the charts, far southward in the Indian Ocean, not over the Indian land region, as Sir John Eliot pointed out (Quarterly Journal of the Royal Meteorological Society, January, 1896). The gradual advance of the southern and western sea breezes in the mighty south-west monsoon we see in the charts for February and March to June. The south-west monsoon reaches Ceylon about the middle of May, and arrives at Bombay about the middle of June. So gradual does the advance seem from April to May and from May to June that it is scarcely noticeable in the charts; but we do, however, find an indication. On the May and June charts we see a higher pressure advancing from south and south-west, while in northern India pressure is decreasing. A pressure wave spreads over India from May to June. This is clearly shown in the following pressure changes from month to month:—

		Changes from		
	° ′	April–May In.	May–June	June–July
Zanzibar	6 12 S. ..	+0·066 ...	+0·069 ...	+0·019
Colombo	6 54 N. ...	−0·014 .	+0·009 ...	+0·016
Trivandrum ...	8 30 N. ...	−0·007 ...	+0·003 ...	+0·009
Mooltan	30 12 N. ...	−0·149 ...	−0·147 ..	−0·019
Dera Ismail Khan	32 0 N. ...	−0·145 ...	−0·161 ...	−0·013

From May to June southern India is flooded with masses of air from the ocean by the south-west monsoon, while over north-west India pressure continues to give way.

Plates xxxvii.–xlix. contain the monthly and anuual mean temperatures over India, the isotherms being drawn for differences of 0°·5 F., and are, therefore, of an especial distinctness. The smaller charts give the lines of equal mean monthly and annual maximum and minimum temperatures. The succeeding plates, l.–lxii., are also devoted to temperature, the large ones showing the lines of equal diurnal range, the small ones the lines of equal absolute maximum and minimum values, monthly and annual. The whole of these plates, therefore, afford a very complete picture of the temperature of India. From the isothermal charts we can easily follow the warming of the Indian land area from south to north-west. In February the warm centre, 82°·5, lies under 16° N. (mean); in March, 87°·5, under about 17° N. (the middle of the peninsula); in April, 92°·5, under 21° N.; in May the centre, 95°, embraces the whole of western India, reaching from 18° to 27° N. In June it takes up a position towards the north-west, in the Punjab—the Mooltan region—with 97°·5, one of the highest monthly temperatures in the world. In July the cooling sets in, 95°, and in August it is 90°, whilst on the Malabar coast, under the influence of the rains, the temperature is already down to 77° (in 12° to 16° N.). In the northern Punjab, where the heat centre lay in June, the temperature sinks to 55° (down to 52°·5) in January. There also are to be found the absolute extremes of the whole of India: 125° in June and 30° to 25° in January. The daily range of temperature varies between 10° on the southern coasts and 32°·5 in the north-west. The rainy season brings to the whole country a great decrease of the daily range of temperature, from 30° and 32°·5 to 15° in Central India.

Plates lxiii.–lxxv. show the distribution, monthly and annual, of the mean daily relative humidity, the two smaller charts on each sheet the distribution at 8 a.m. and 4 p.m. In the Central Provinces in April the atmospheric humidity decreases to 30 per cent. in the daily means, and to 20 per cent. at 4 p.m., whilst on the coast it is 70 per cent., and in Upper

Assam 80 per cent. On the west coast during the rainy season it is 90 per cent.; in the Punjab 50 per cent. to 60 per cent. In similar manner Plates lxxvi.–lxxxviii. show the mean distribution of aqueous vapour, monthly and annual, and at 8 a.m. and 4 p.m., the changes are mostly the reverse of those of relative humidity. The mean vapour pressure reaches 0·90 inch to 0·95 inch on the coasts and over the Bay of Bengal in May, while in January it is only 0·40 inch over the land. The rainy season brings to the whole peninsula a high vapour pressure, but on account of the decrease of temperature it is generally not higher than 0·85 inch; only in the lower and middle Ganges valley is it 0·95 inch. The daily variations of the relative as well as of the absolute humidity are very great in the dry season.

The charts exhibiting the distribution of humidity are followed by Plates lxxxix.–ci., showing the mean daily cloud distribution. Here also we find smaller charts representing the cloudiness at 8 a.m. and 4 p.m. Such an exhaustive picture of cloudiness as we have presented to us in these Indian charts did not hitherto exist for any part of the world. The difference in the cloudiness in various parts of India in the several seasons is very great. In the middle Indus valley we find a mean cloudiness of 1·5, in Upper Assam of 6·0—these are the extremes in the annual means. In June the Punjab has still only 1·0, the Malabar coast and Assam 8·0, in western Bengal even 9·0. In October the minimum, 0·5, lies in the Punjab, the maximum, 8·0, in southern Deccan. The technical finish of these maps is especially beautiful and impressive.

We now come to the concluding series, Plates cii.–cxx., representing the rainfall conditions. The principal charts, monthly and annual, show the rainfall distribution by means of isohyets; the smaller ones give the lines of equal mean number of rainy days and the storm tracks for 1876–1901. Until now no monthly rainfall charts for India had been in existence. H. Blanford had added to his great work on the rainfall of India ("Memoirs," vol. iii.) merely an annual chart. The principal areas of rainfall in India—the Malabar coast and the Khasi Hills of Assam, with from 200 inches to 450 inches of rain annually—are generally well known; but what we regard as the most extensive rain region is the Malabar coast rather than the Khasi Hills, as is especially evident from the June and July charts. On the Malabar coast in July we find a long area with 50 inches of rain, whereas the Khasi Hills have only the isohyet of 20 inches (Cherrapunjee omitted). In June both regions have isohyets of 30 inches. The driest region is in the lower Indus valley (round the hottest place in India—Jacobabad), with an annual total of only 5 inches. The mean values of the number of rainy days lie between the limits of 10 on the lower Indus, 125 on the Malabar coast (Cochin) and in Assam, and 200 in the south-west part of Ceylon. The isohyets are also drawn for the seasons—for January and February, March to May, June to October, and November and December (the main annual Indian seasons), and also for the combined results for December to April and for May to November. The smaller charts show the number of rainy days, and for January, May, July, and October the midday isobars at an elevation of 10,000 feet. On the chart for January and February appear the welcome rains of northern, and especially north-western, India, shown by isohyets of from 2 inches to 5 inches; on the March to May chart the spring rains in Assam, from 20 inches to 30 inches, and on the west coast of Ceylon, 20 inches, are particularly noticeable.

Of special interest are fifteen smaller charts giving the storm and cyclone tracks (period 1876–1901). In the winter half of the year, the cool season, we find the storm tracks (paths of the depressions) in north India, mostly north of 24° N. First, in November there are two, in December thirteen storms in the direction from the lower Indus towards the Ganges delta. In January there are more than thirty northward of 24° N., while there are only four southward to 20° N. In February they still remain in northern latitudes; we see two main paths with twenty-five tracks—in March not more than twelve. This seems to be the end of the period of winter storms in north India. On the April chart we already find the tracks of four great cyclones over the Bay of Bengal, the Arabian Sea, and from the latter two advancing towards north-western India. To the cyclone tracks are attached the dates, so that the direction and velocity can be ascertained, but with the storm tracks we miss an indication of the direction of movement of the depressions (say by means of an arrow). We certainly know that in the winter half-year in northern India these tracks are generally directed from west to east, but as we proceed through the year there are doubtful cases, as the summer depressions from the Bay up to the Ganges valley and westward towards Central India. In May, and again in October and November, we find numerous tracks over the Bay; in November also over the Arabian Sea. In this month two cyclones crossed the peninsula, and, therefore, the Ghats, from the Bay to the Arabian Sea (between 12° and 14° N.)—rare cases. In December only one great cyclone moved up the Bay from south to north, and some smaller ones from east to west. During the rainy season (June to September) the upper north-west corner of the Bay becomes the birthplace of numerous depressions, which pass into the country. In September this "area of cyclonic storm generation" extends further south to 15° N., and also goes further into the Bay. These are the storms which carry the rains of the Ganges valley upwards and over Central India. During the months of June to August it appears that even on the land depressions are developed which go westward (direction of movement wanting) as far as the Indus. Three small charts show these land-formed storm tracks (period 1886–1900).

We now conclude our cursory examination of the very richly-stored volume of charts lying before us, for which science as well as practice, so long as they have to depend upon climatic factors, are indebted to the Indian Government. Sir John Eliot, the author of this work, has produced a worthy monument of himself as the director of the Meteorological Service of India. We now look forward with the greatest interest to the promised "Manual of Indian Climatology," which, as an addition to the "Atlas," and especially in the interest of the general public, is indispensable. Our knowledge of the meteorology of India has now extended so far beyond the region of the instructive and concise work of Henry F. Blanford, "Climate and Weather of India" (London, 1889), that a new description on a broader foundation appears to us an absolute necessity.

J. HANN.

A NEW TREATISE ON EVOLUTION.

Einführung in die Deszendenztheorie. Sechs Vorträge. By Prof. Karl Camillo Schneider. Pp. viii + 147. (Jena: Gustav Fischer, 1906.) Price 4 marks.

THIS is a book with many good points. It gives a fairly complete account of current opinion on the subject of evolution, including the most recent views concerning the nature of variation and the laws of inheritance. Most of the facts cited are sufficiently familiar, but they are explained with unusual lucidity and conciseness. Where authorities differ, their conclusions are as a rule impartially stated; and when, as often happens, the author's own judgment is at fault, he will generally be found to have supplied his readers with material for forming a sounder opinion. The illustrations are copious and well-selected, and the book as a whole will serve as an adequate introduction to modern evolutionary theory.

So far as argument goes, the most effective part of the work is its criticism of Lamarckism, from which, however, we miss any mention of Prof. Ray Lankester's convincing demonstration of the self-contradictory nature of Lamarck's "laws." The author appears to attach far too much importance to the "mutations" of de Vries, and regards as well-established certain conclusions on this head which recent researches have seriously shaken. His objections to the part assigned to selection by Darwin and his followers are singularly feeble, and we are not surprised to find that his knowledge of many of the most important facts bearing on this branch of the subject is imperfect. His account of mimicry, for instance, is quite out of date; and the vast mass of highly significant material that has been accumulated under the influence of Fritz Müller's theory of common warning colours is almost entirely ignored. An error, or rather a series of errors, which unfortunately found their way into Weismann's latest work (as pointed out in NATURE, vol. lxxii., 1905, p. 201), reappears in the coloured plate appended to the present treatise. As these errors remain uncorrected in the English translation of Weismann, and have since been copied into several other publications in Germany and America, it may be well to direct attention to them here in detail.

In the plate referred to (Taf. II.), Fig. 1 represents, not, as stated, the male of *Papilio merope,* but the female of the north-east African form, *P. antinorii.* Figs. 3 and 4 are not "forms of *P. merope* from South Africa," Fig. 3 being the *hippocoon* form of the female of *P. tibullus,* a race of *P. dardanus* which occurs in East Africa from Mombasa to Delagoa Bay, and Fig. 4 representing the female of *P. echerioides,* a species quite distinct from the *dardanus* or *merope* group. The butterfly represented in Fig. 6 is not, as stated, *Amauris niavius* from South Africa (the form usually called *dominicanus*), but belongs to the West African race of the species. Finally, in Fig. 7 is shown, not the Danaine *Amauris echeria,* "the immune model of Fig. 4," but another Papilio, viz. the *cenea* form of *P. dardanus* ♀, the mimic having been here mistaken for its model. These mistakes are the less excusable in that several of the forms in question have been carefully discussed and figured by Prof. Poulton.

The great difficulty to be faced by those who, like the author of the present treatise, seek to minimise the influence of selection, is the universal prevalence of adaptation. We accordingly turned with some interest to the passages in which he gives his own solution of the problem. We must confess to a feeling of disappointment. The author makes no serious effort to grapple with the question; he appears to be satisfied with vague phrases about "extra-personal correlation" which explain nothing, while his dictum —emphasised by spaced type—"Artbildung ist einerseits Vervollkommnung, andererseits Anpassung," when taken with its context, seems to savour of the heresy of orthogenesis. However, he claims for his book that it is only an introduction, not an attempt at explanation, and in both parts of the claim we think he is justified.

F. A. D.

OUR COAL RESOURCES.

The Coal Question. By the late W. Stanley Jevons. Edited by A. W. Flux. Third edition. Pp. l+467. (London: Macmillan and Co., Ltd., 1906.) Price 10*s.* net.

THE first edition of Jevons's lucid and exhaustive work was published in 1865 and the second in 1866, and since that date it has constantly been referred to, but almost always misunderstood. The Royal Commissions of 1866 and 1901 both shared the general misunderstanding. This is certainly surprising in view of the care the author took to make his position clear. He argued that within a century the want of coal would seriously check our material progress if the rate of progress in consumption shown at the time at which he wrote were maintained.

Since Jevons's tragic death in 1882 (NATURE, vol. xxvi., p. 420), no one has pointed out the superiority of his logical method over that of his many critics. It is, therefore, a matter for congratulation that Prof. Flux, of McGill University, who was formerly Stanley Jevons professor in the Owens College, Manchester, has edited a third edition, in which he has wisely preserved the text unaltered so far as might conveniently be done, while making such additions as were necessary to embody the knowledge accumulated in the forty years since its original issue. The most important change in the general situation since then is the development of the coal resources of Germany.